Searches for direct electroweak production of charginos, neutralinos and sleptons with leptons and E_T^{miss} (CMS)

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on behalf of the CMS Collaboration.

Universidad de Oviedo

SUSY14
The 22nd International Conference on Supersymmetry and Unification of Fundamental Interactions.

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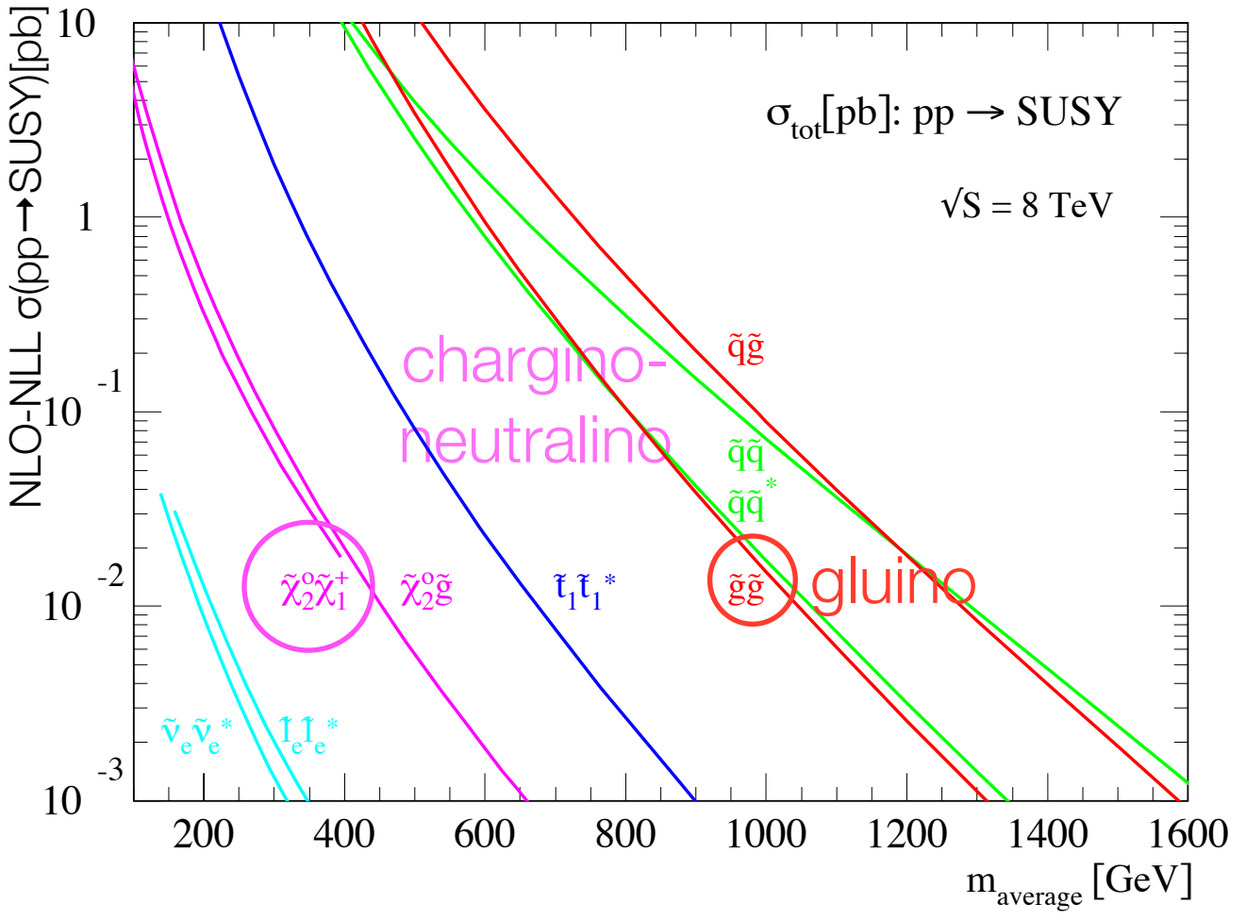
Motivation

Most of CMS SUSY searches focus on strong production, with larger cross section.

Limits on these models probe masses of squarks and gluinos up to ~1.2 TeV.



Heavy squarks and gluinos may favour models with direct EWK production of charginos, neutralinos and sleptons with low hadronic activity associated.

Charginos and neutralinos will decay then to sleptons or W, Z or h bosons.

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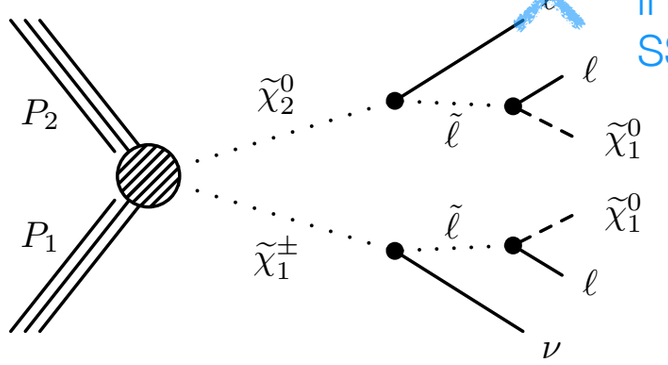
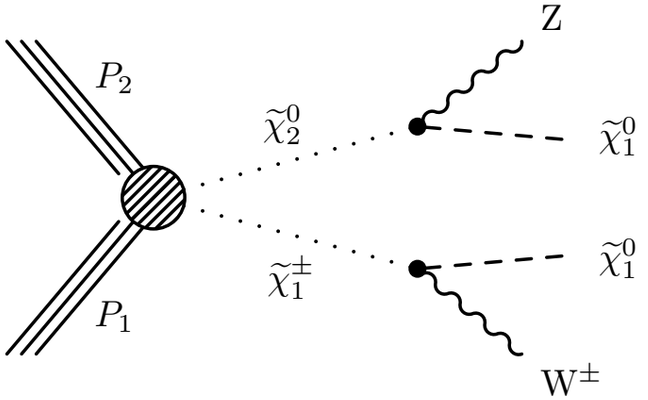
Electroweak SUSY production @CMS



if one missed: SS analysis

light sleptons and sneutrinos.

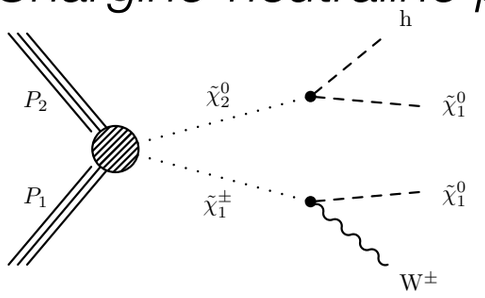
3-lepton search
same-sign analysis



heavy sleptons, decays to W/Z.

multilepton search.
2-lepton + dijet + MET.

Chargino-neutralino production

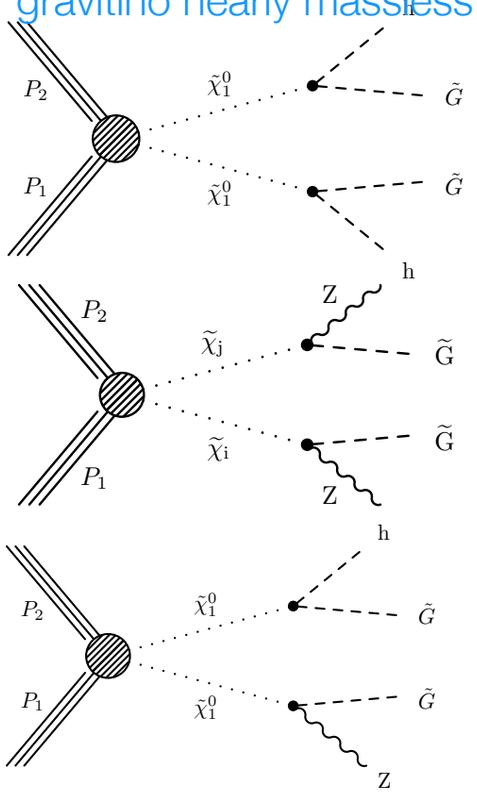


The lightest neutralino is massive and the LSP

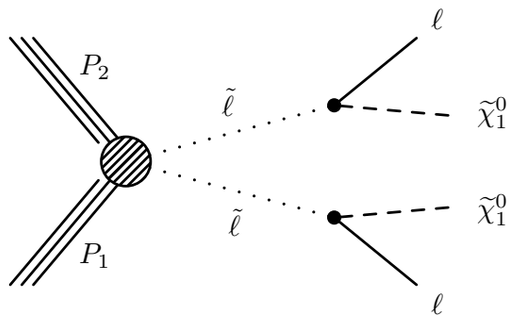
Decay to h, W or Z bosons.
h → bb, ττ, WW, ZZ and γγ

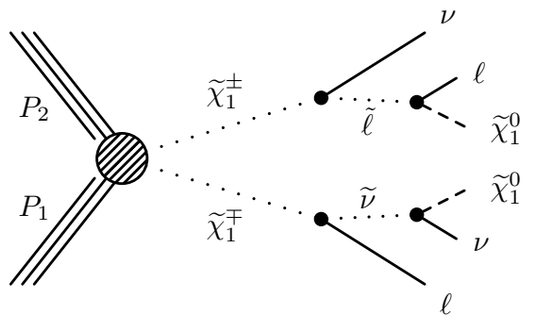
final states
- ***4b's***
- ***1 lepton + b's***
- ***SS dileptons***
- ***multileptons***

gravitino nearly massless.



GMSB model with higgsino NLSP.

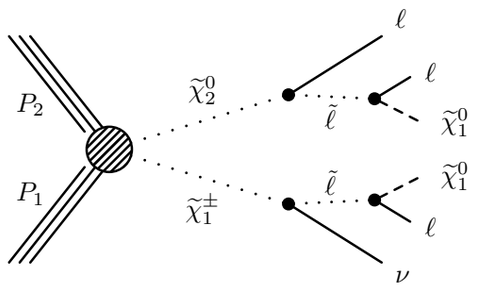




direct production of charginos or sleptons:

OS dilepton analysis

3 lepton search



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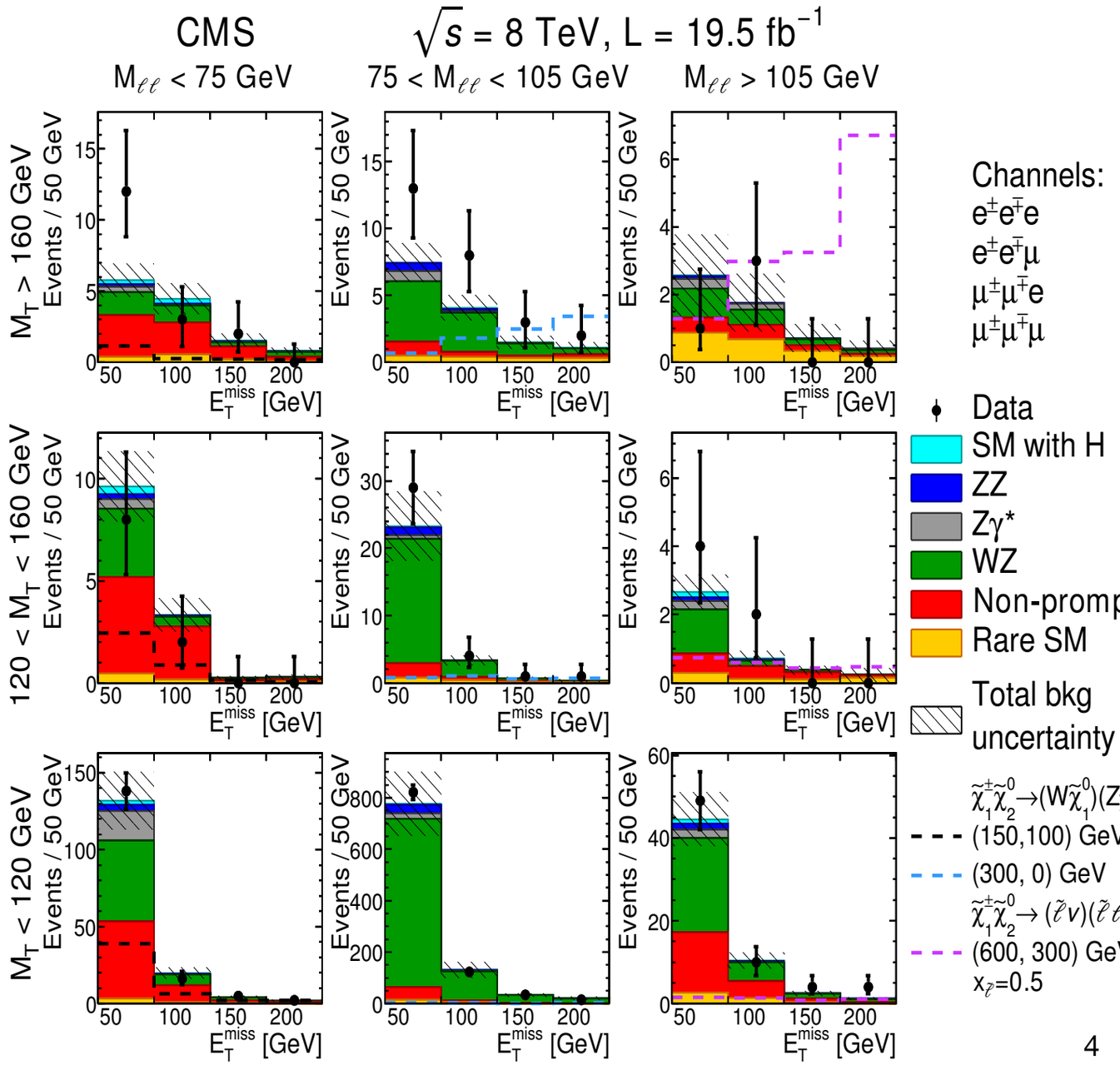
Events with exactly 3 leptons (including 2l+τ_{had}). B-jet veto to suppress ttbar and E_T^{miss} > 50 GeV to suppress Z+jets.

Signal regions: Use 3D binning to optimize S/B separation, E_T^{miss}, M_T and m_{ll}.

Multiple final states: 3e/μ with(out) OSSF pair, SS+τ_{had} or OS eμ + τ_{had}.

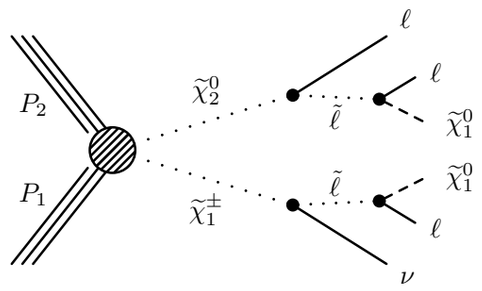
Backgrounds: Data driven for non-prompt leptons. WZ from MC with corrections from data.

Results: data consistent with prediction for the full phase space.



arXiv:hep-ex/1405.7570

Same-sign analysis



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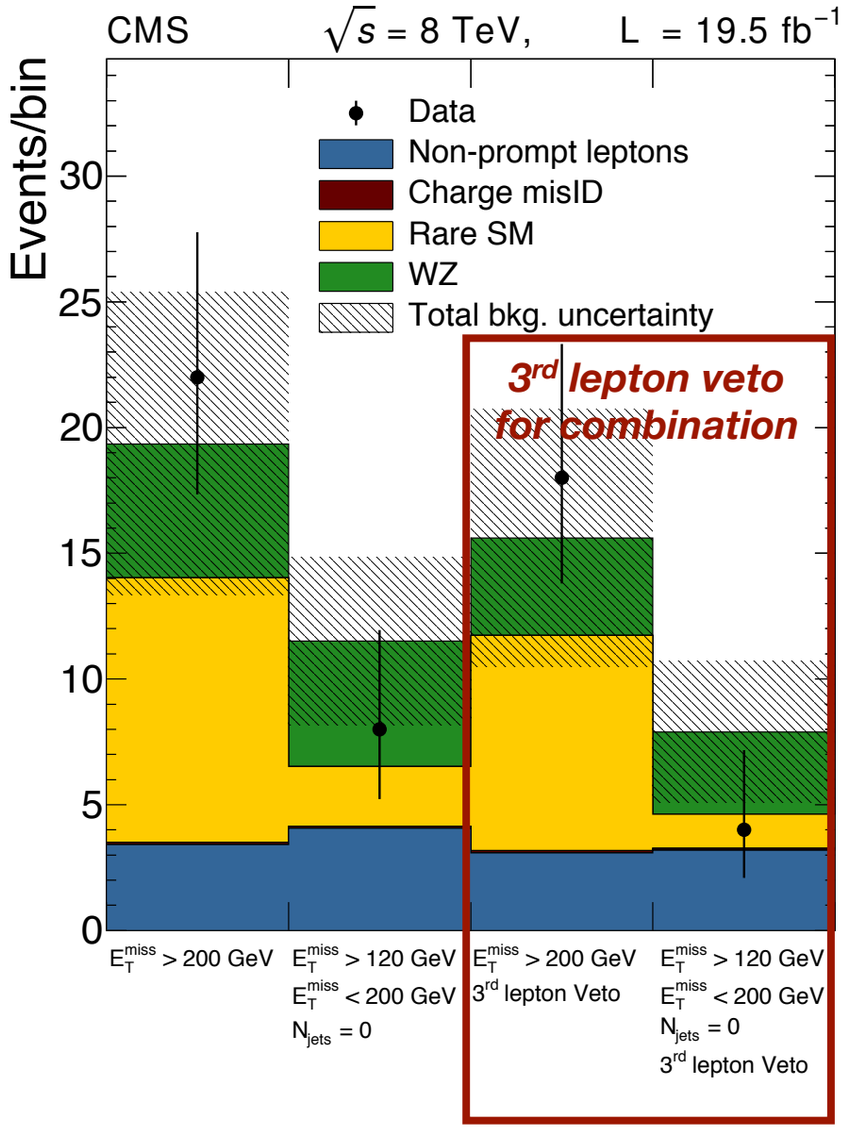
Small mass splitting, only 2 leptons reconstructed. SS recovers missing events from 3l.

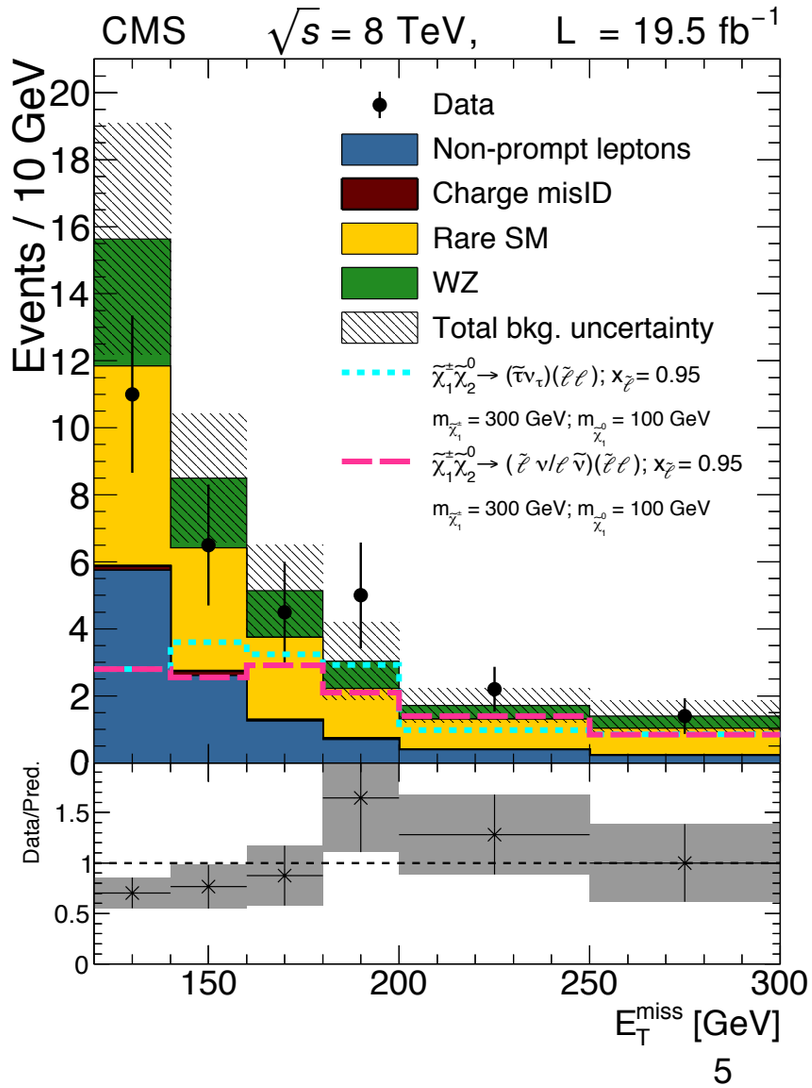
Events with **2 same-sign leptons** and **E_T^{miss} > 120 GeV** and no third lepton within the Z mass.

Signal regions: tightening E_T^{miss} or vetoing hadronic activity.

Backgrounds: Rare SM decays (MC), WZ (MC), fake leptons (data-driven) and charge flips (data-driven).

Results: good agreement with SM prediction.





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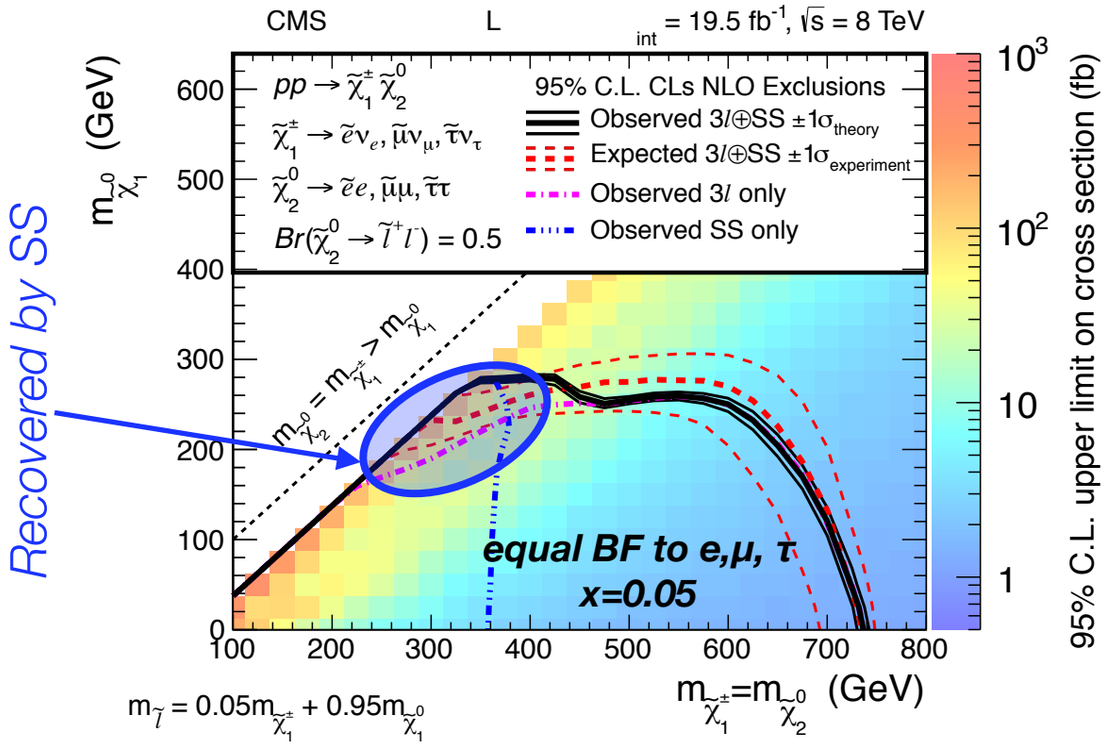
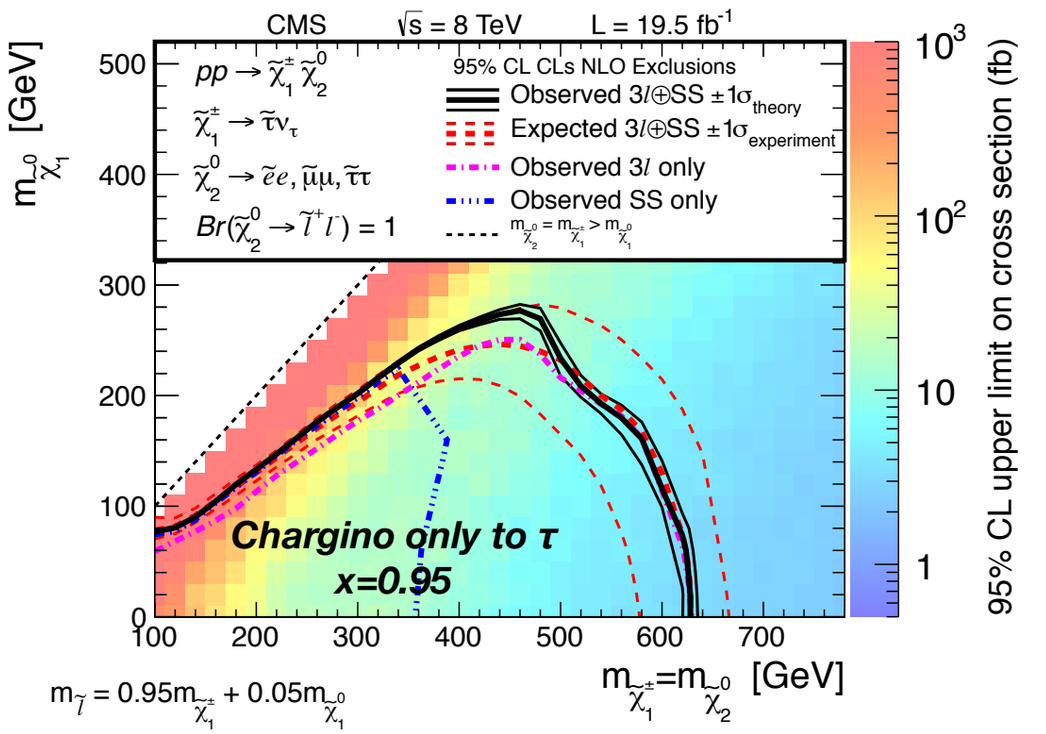
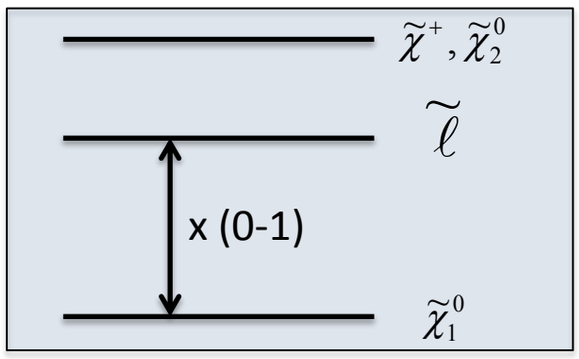
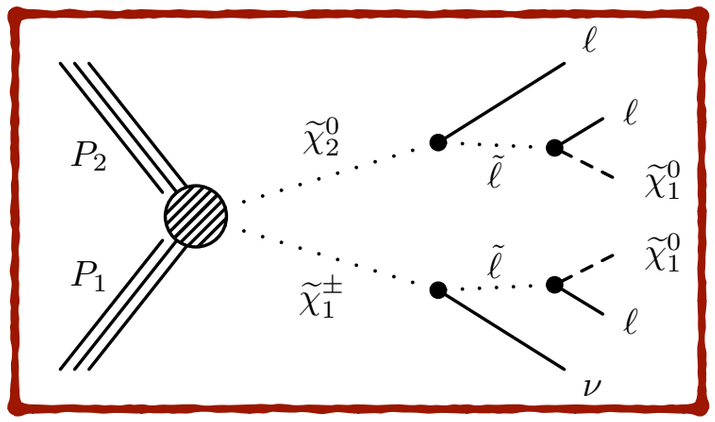
Chargino-neutralino production

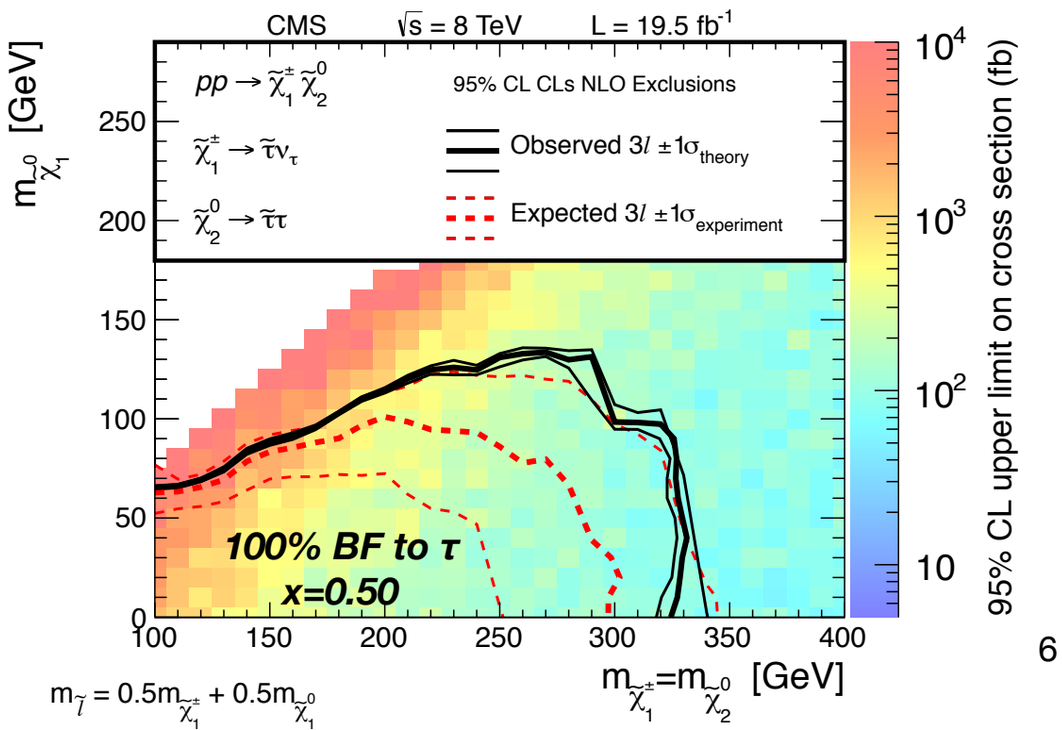




Results are interpreted in several scenarios and different mass splittings (only a sample shown here).







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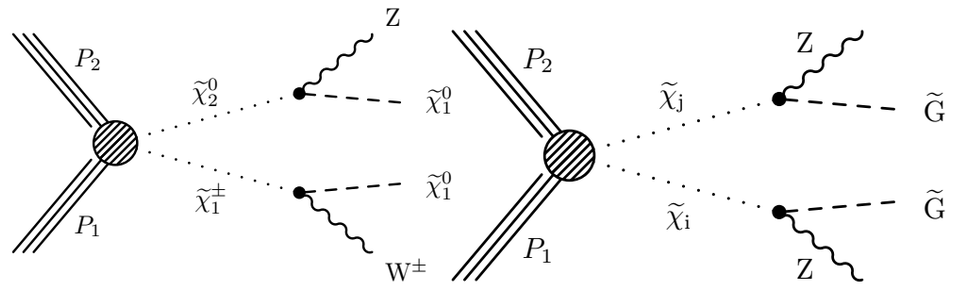
Z+dijet analysis.



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Select events with a Z candidate to ee/μμ and no other lepton.

b-jet veto to suppress ttbar.

2jets compatibles with a W boson.

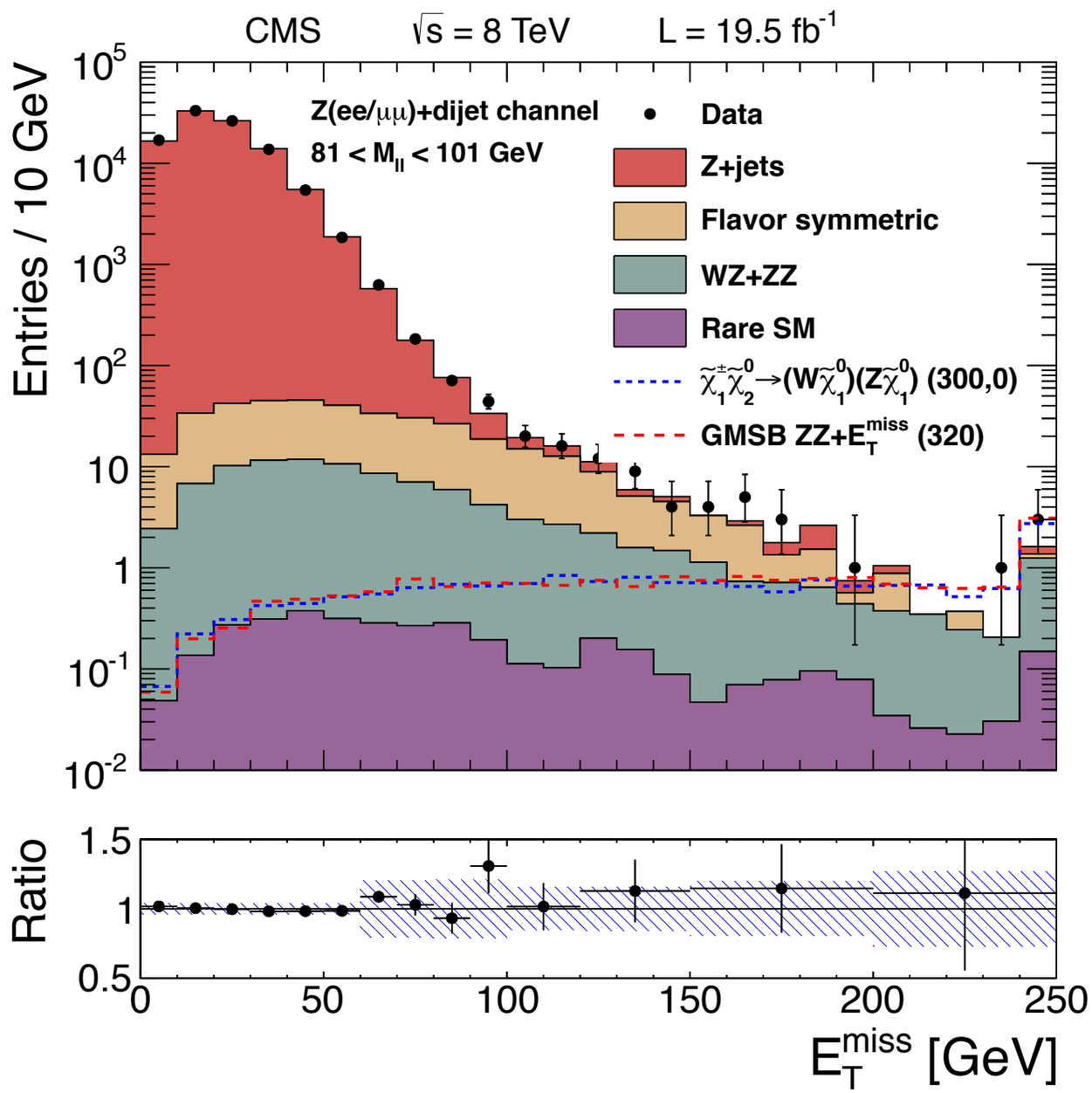
Signal regions: binned in E_T^{miss} bins.

Backgrounds:

Z+jets modelled using γ+jets templates.

Flavour symmetric estimated from eμ data.

Results: data well described in all bins.



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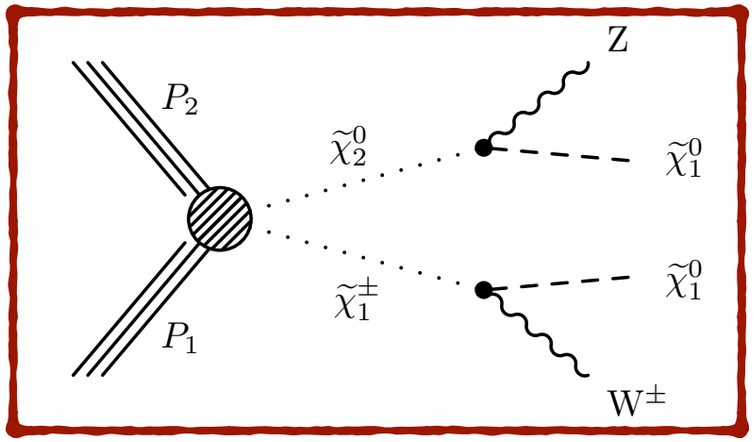
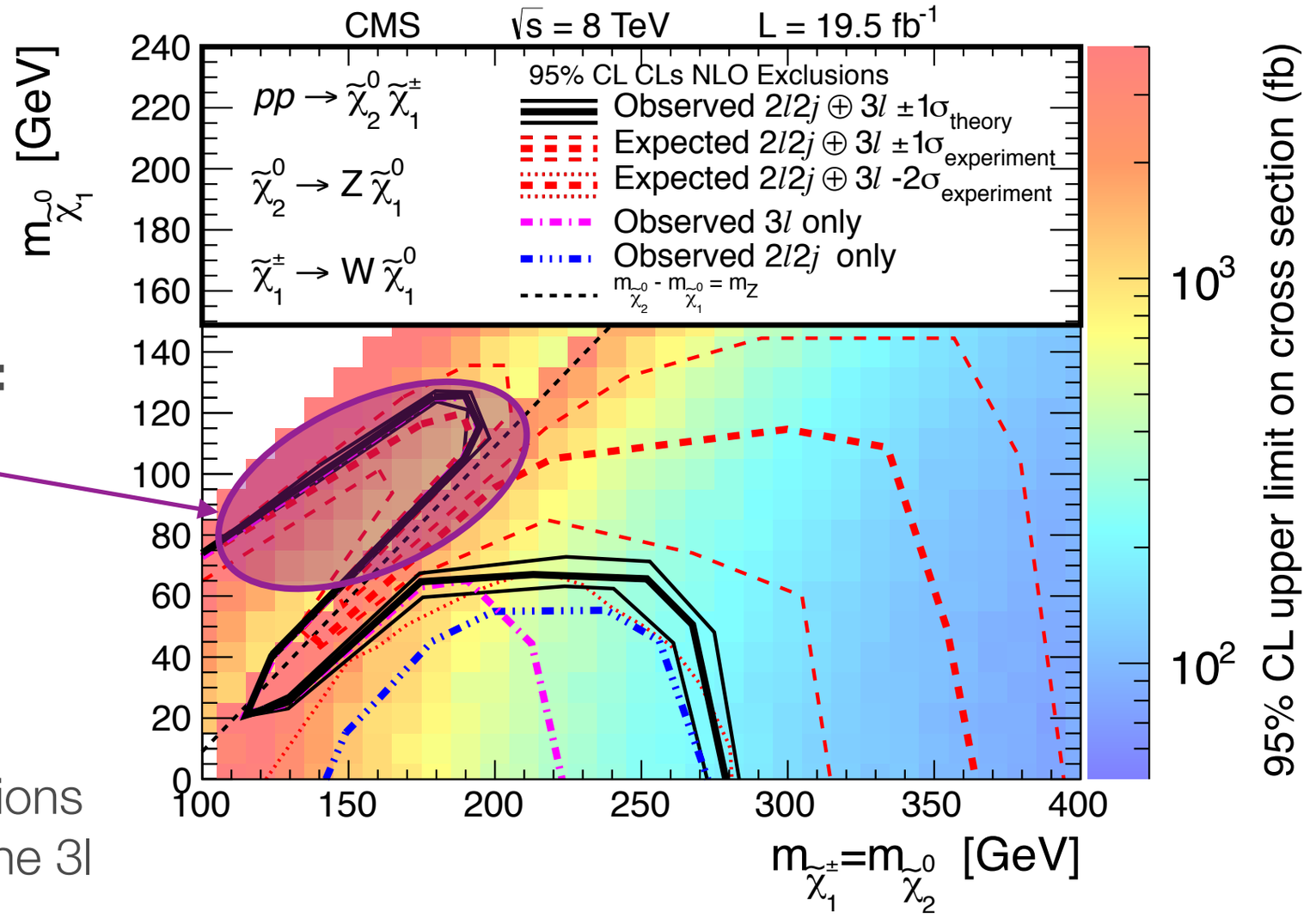
Chargino-neutralino production to WZ



Very complementary analysis:

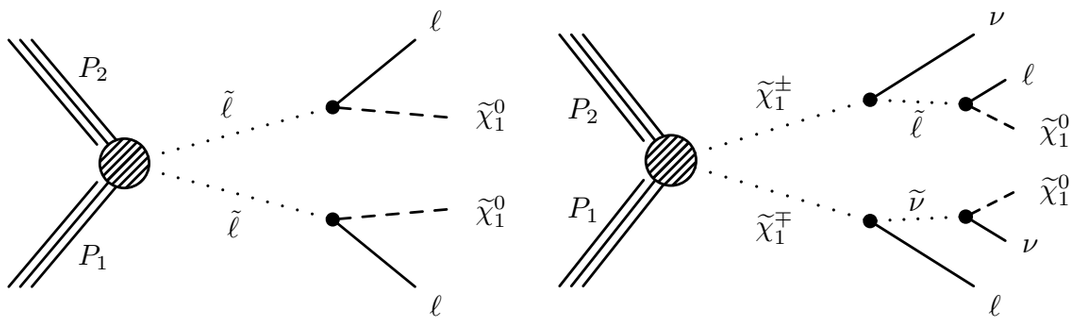
- 3l without a Z candidate
- Z+dijet analysis
- 3l with a Z candidate.

Observed limit is below expectations due to small underprediction in the 3l analysis (high M_T bin)



arXiv:hep-ex/1405.7570

OS dilepton



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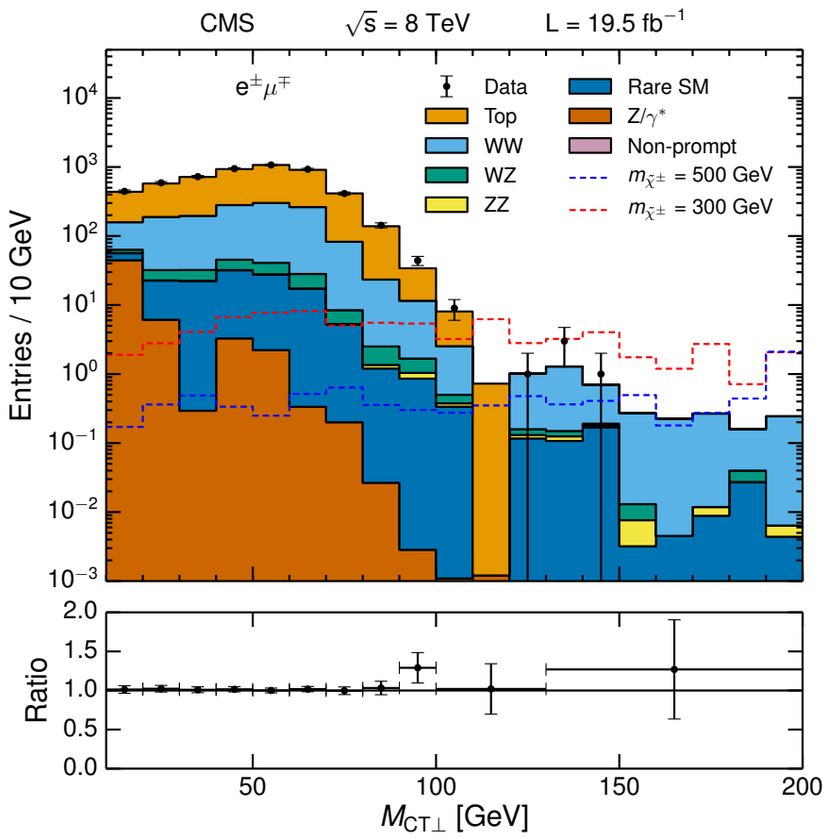
Select events with 2 OS dileptons (SF and DF). b-jet veto to suppress ttbar, $E_T^{miss} > 60$ GeV.

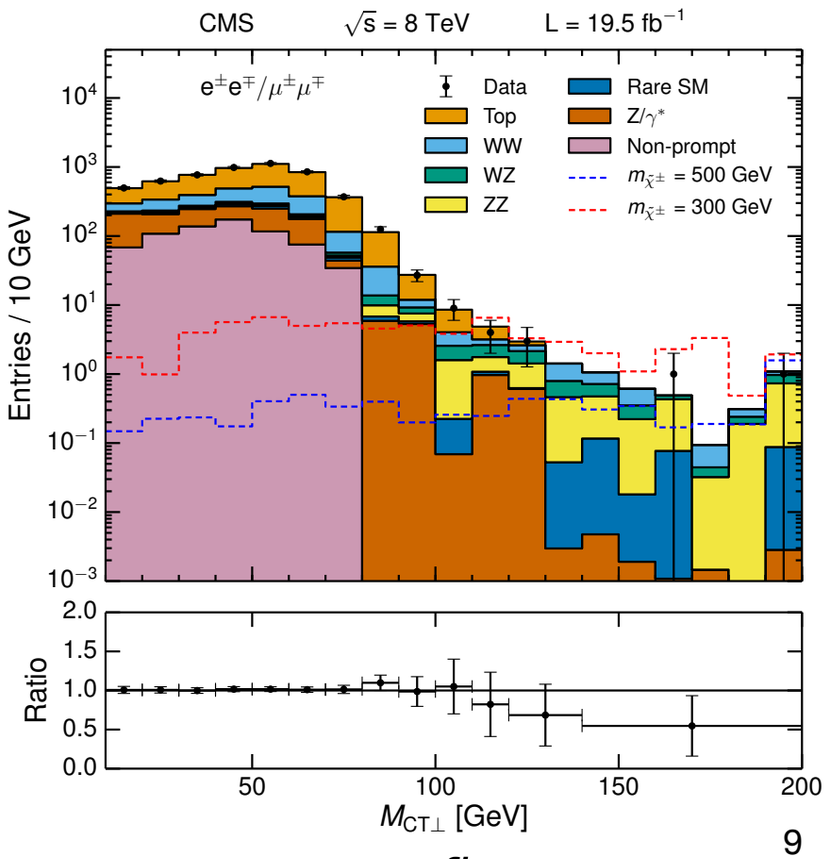
Signal region: fit $M_{CT\perp}$ shape (endpoint at W mass)

Background prediction: fit templates from MC and data-driven control regions.

Results: MC prediction agrees well with data.



different flavour



same flavour

arXiv:hep-ex/1405.7570

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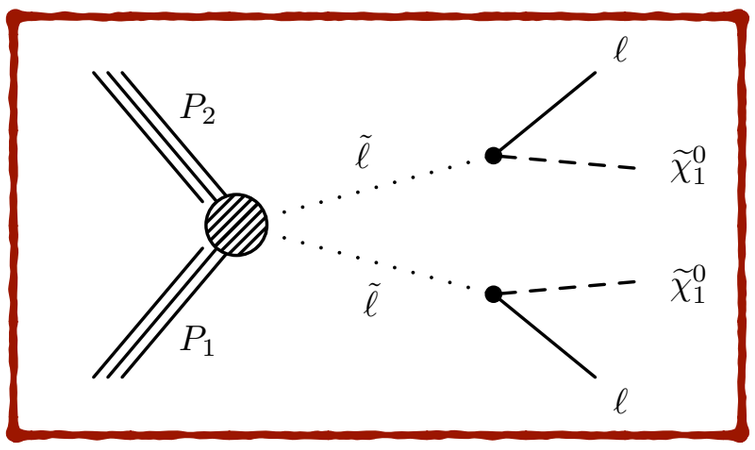
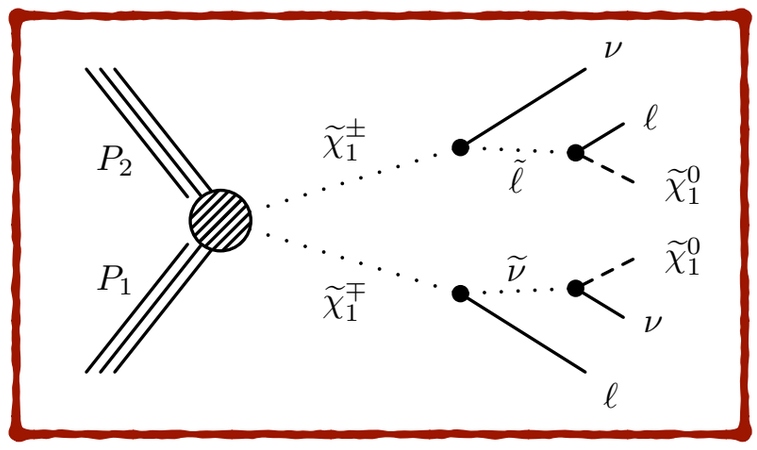
Chargino and slepton pair production





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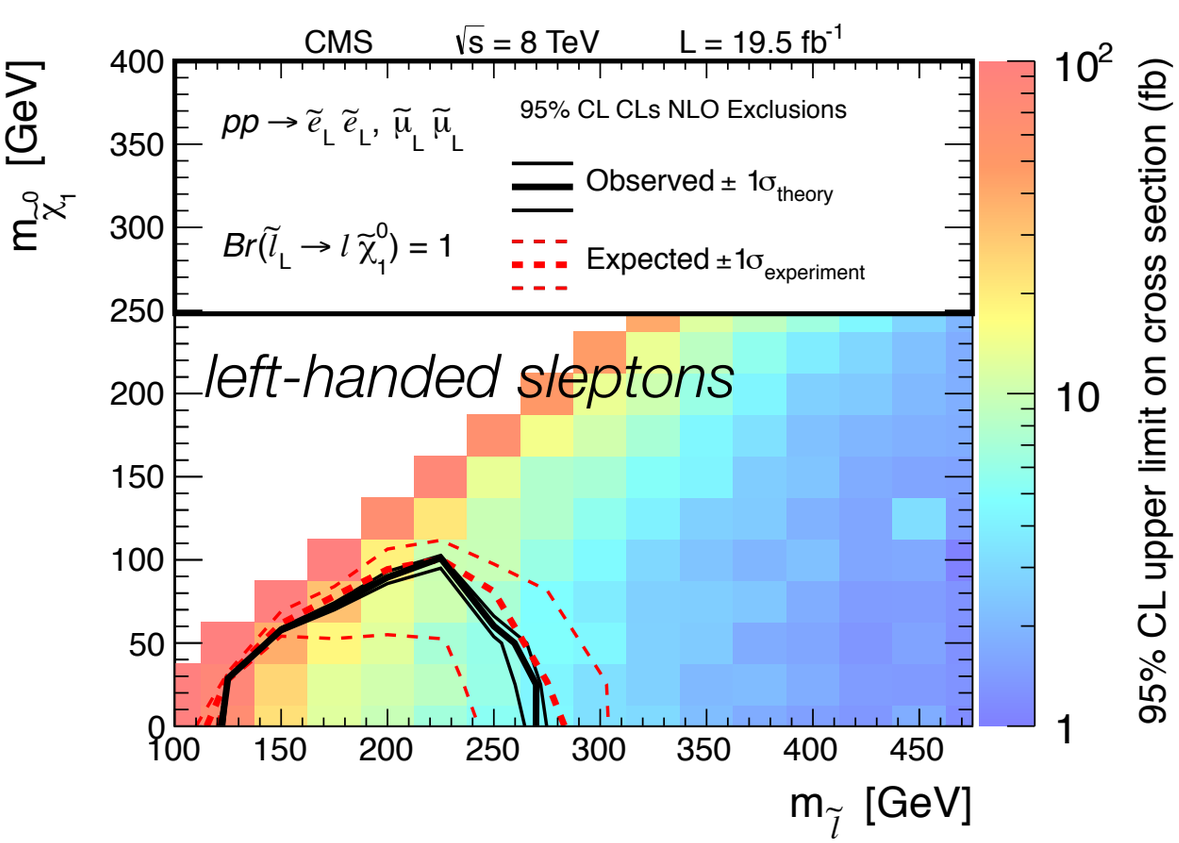
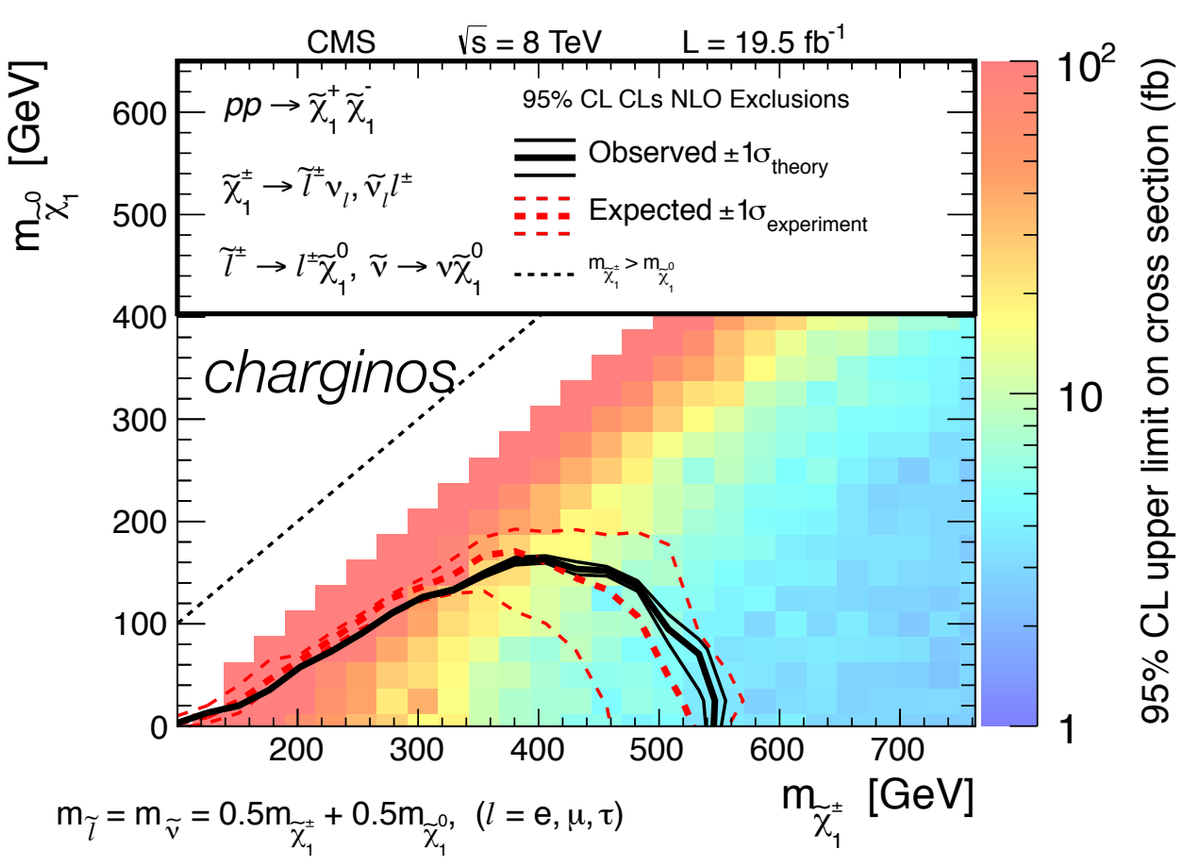


same flavour



different flavour

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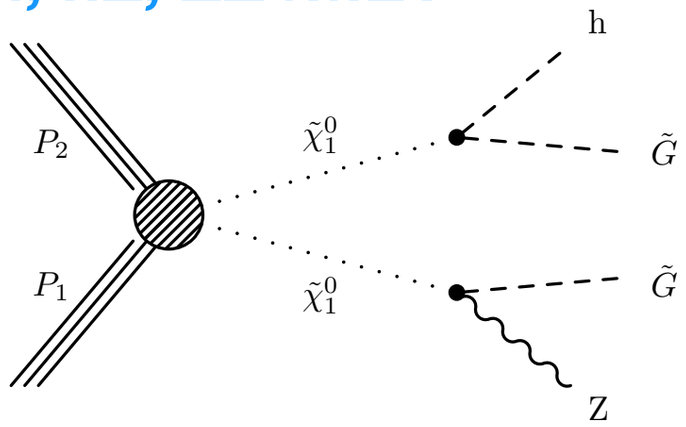
Chargino-neutralino with higgs decays.

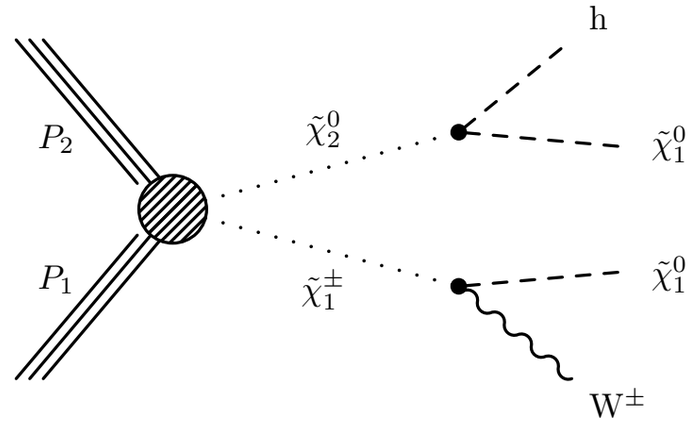
GMSB model with higgsino NLSP and ~massless gravitino LSP.

hh, hZ, ZZ+MET



Chargino/neutrino production with massive neutralino as LSP.

hW + MET



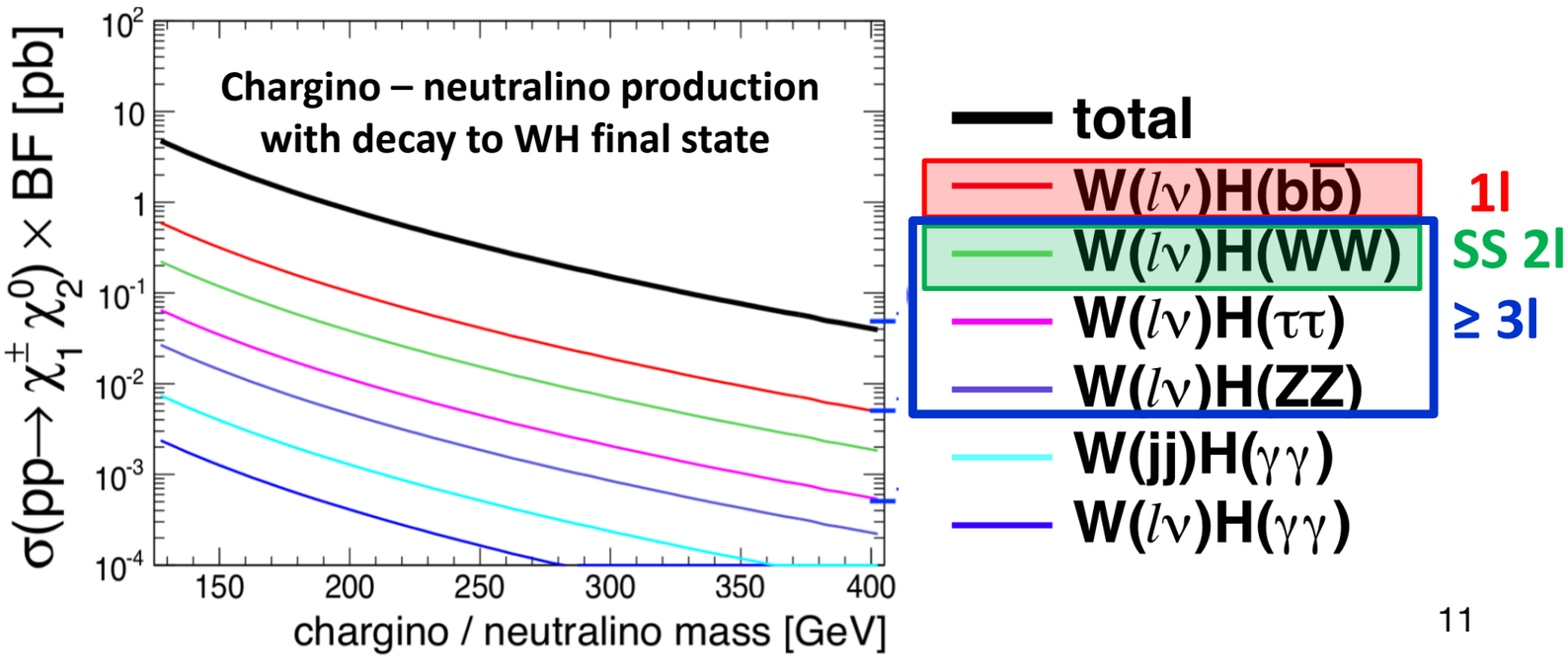
Final States covered today:

2γ + leptons. *(hh, hZ, hW)*
2l + 2jets *(hZ → bb̄l⁺l⁻ and ZZ)*
~~*others with 4b's or 2γ + 2(b)jets*~~

hW

1lepton + 2b's (hW)
SS dilepton (hW)
multi-lepton (hW)

see talk by G. Hanson



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hh, hZ and hW to γγ + lepton

Includes hh with one h decaying to WW, ZZ or ττ.

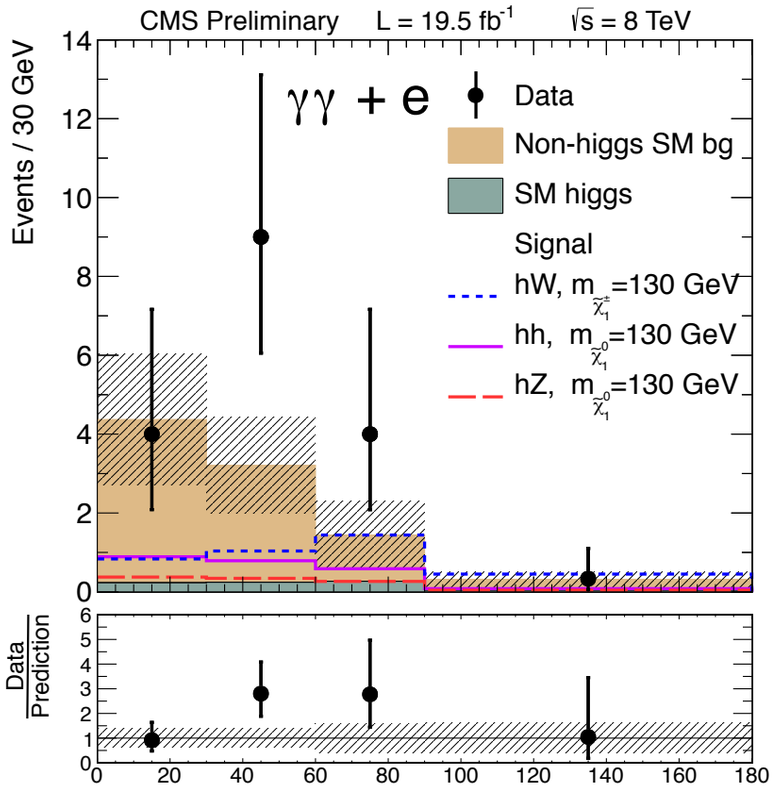
Select events with at least one muon or no muons and at least one electron and at most 1b-jets (avoid overlap)

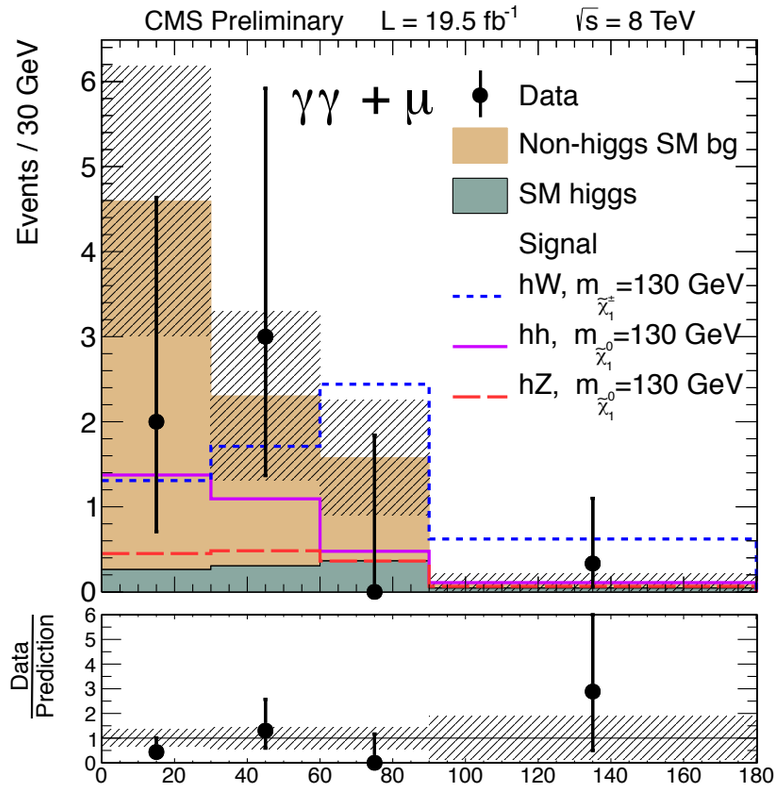
Signal region: Use M_T as discriminating variable.

New

Backgrounds: non-SM higgs estimated fitting the $m_{\gamma\gamma}$ sidebands.

Results: muon channel in agreement with prediction, electron channel shows an excess of 2.1 consistent with BG fluctuation.





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hZ to b$\bar{b}$(l^+l^-)

Selection:

New

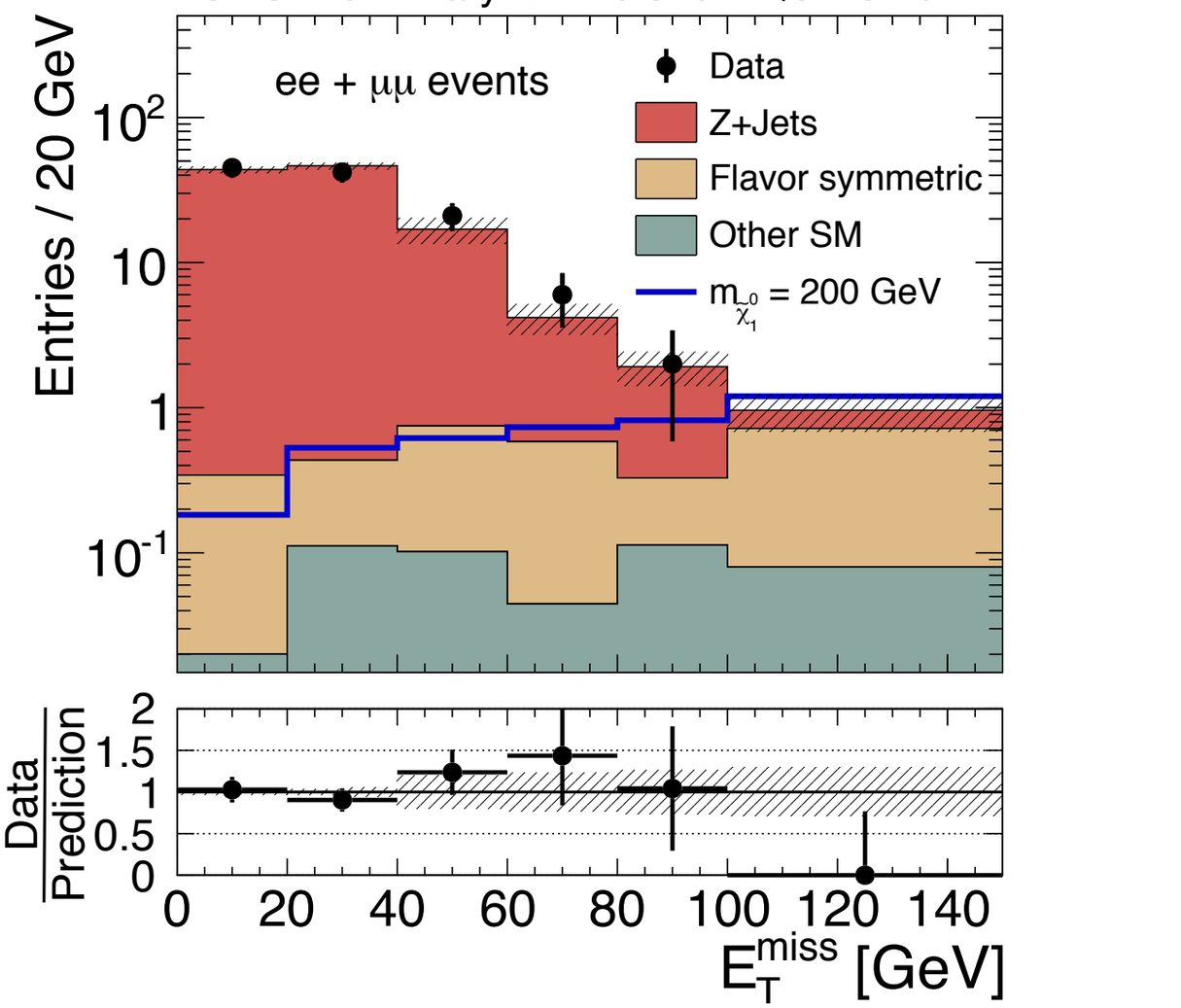
Higgs reconstruction: **two most b-like jets** with $100 < m_{bb} < 150$ GeV.

Z reconstruction: **exactly two same-flavour OS pair** with $81 < m_{ll} < 101$ GeV.

Signal region: Use E_T^{miss} bins.

Backgrounds: Z+jets modelled using γ +jets templates normalised to data. Flavour symmetric background from a E_T^{miss} template normalised to eμ sample. Other from MC.

Results: Consistent with SM predictions.



CMS-PAS-SUS-14-002

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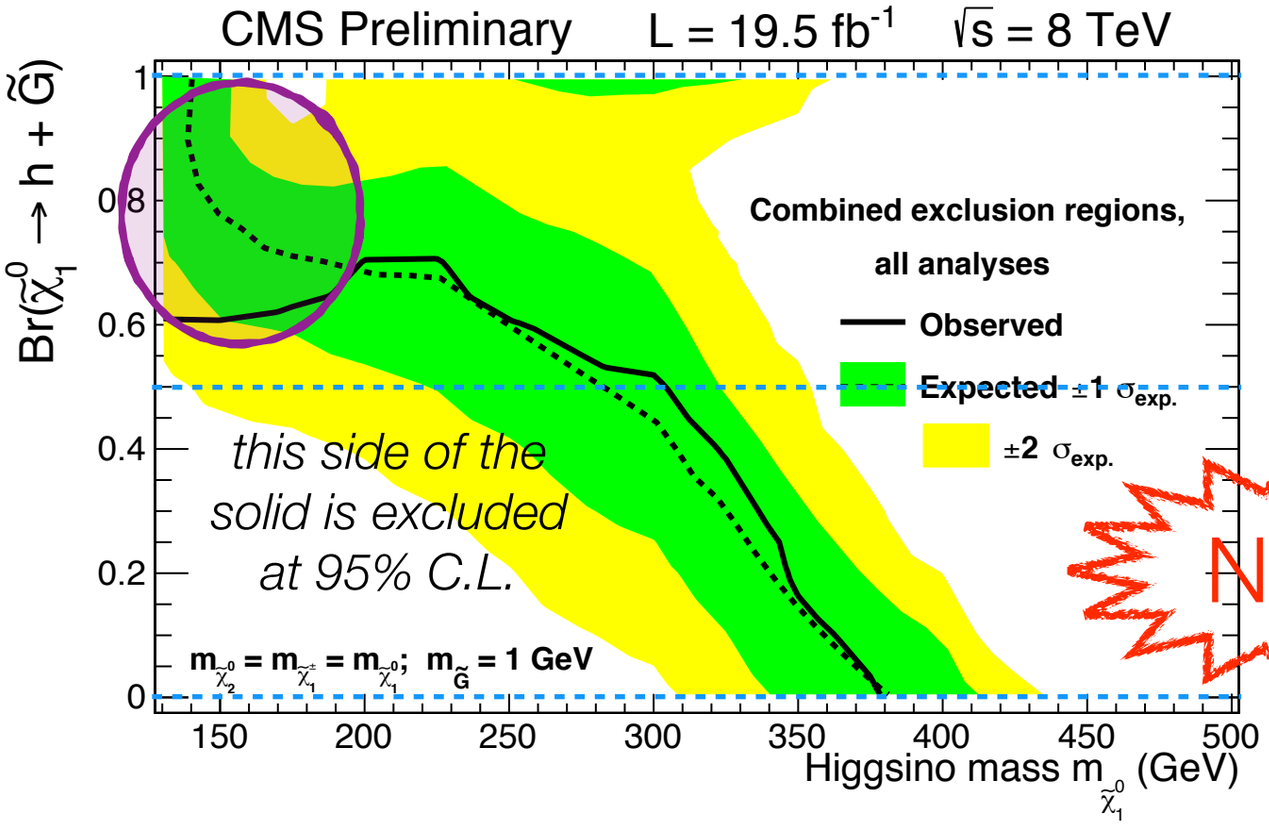
hh and hZ: GMSB higgsino interpretation.

GMSB scenario where charginos and neutralinos are higgsinos (nearly degenerated). The LSP is the gravitino. NLSP is the lightest neutralino.

Using also other final states not described in this talk.

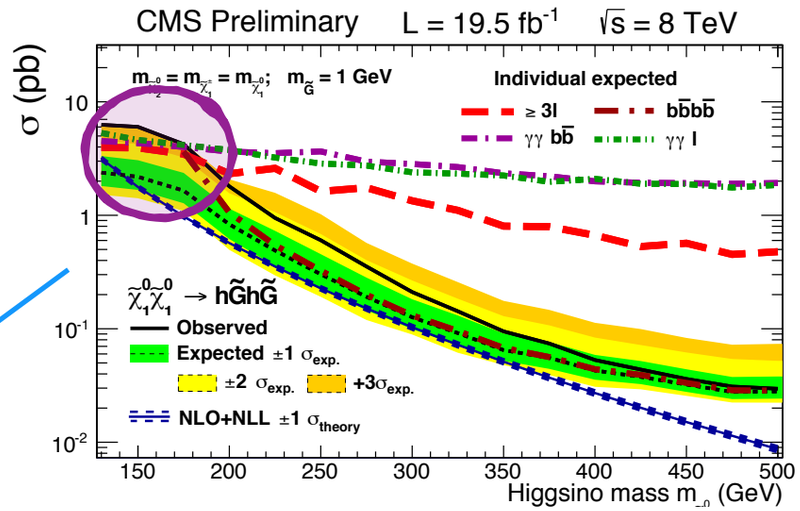


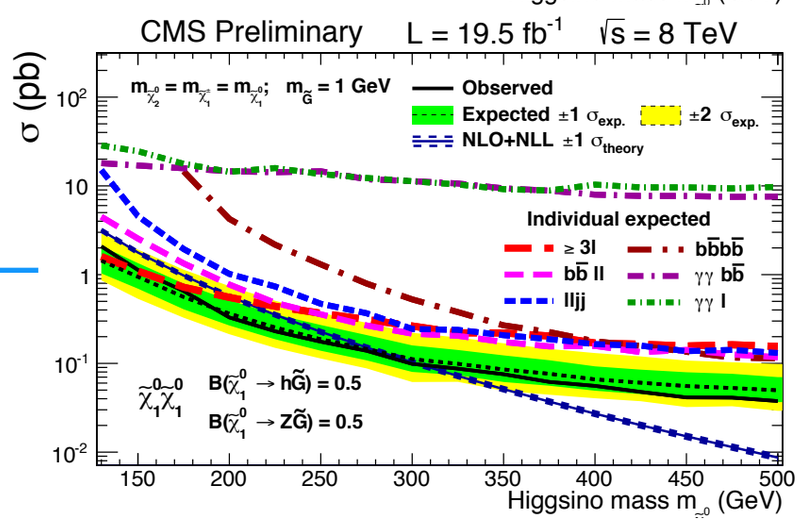
100% hh

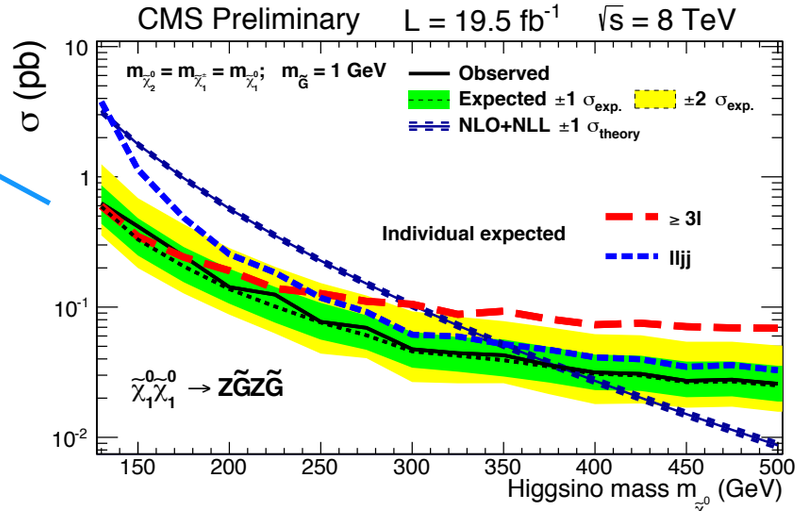
25% hh
50% hZ
25% ZZ

New

100% ZZ







Production cross-section vs higgsino mass (right plots).
BR (chargino to higgs-gravitino vs higgsino mass (left plot)

CMS-PAS-SUS-14-002
3l result from: arXiv:1404.5801

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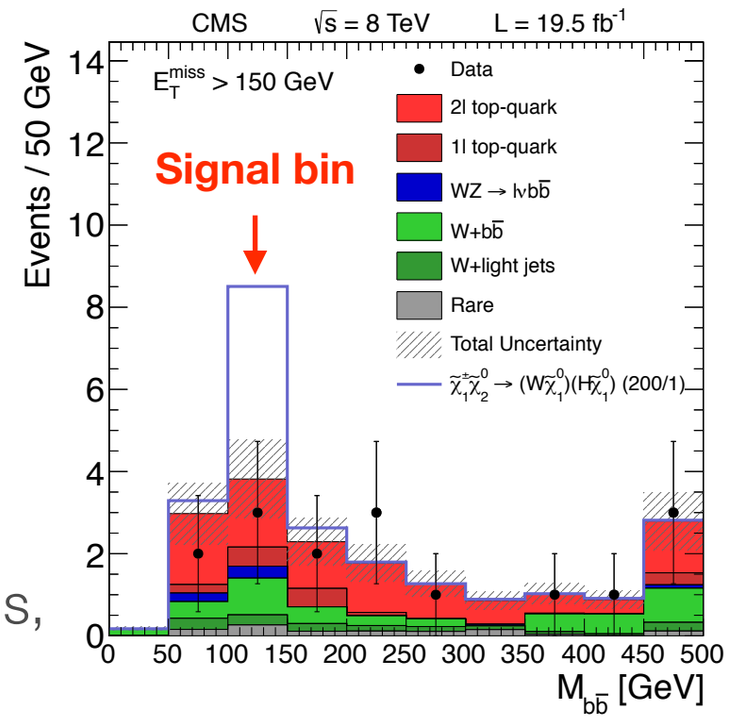
hW analysis.

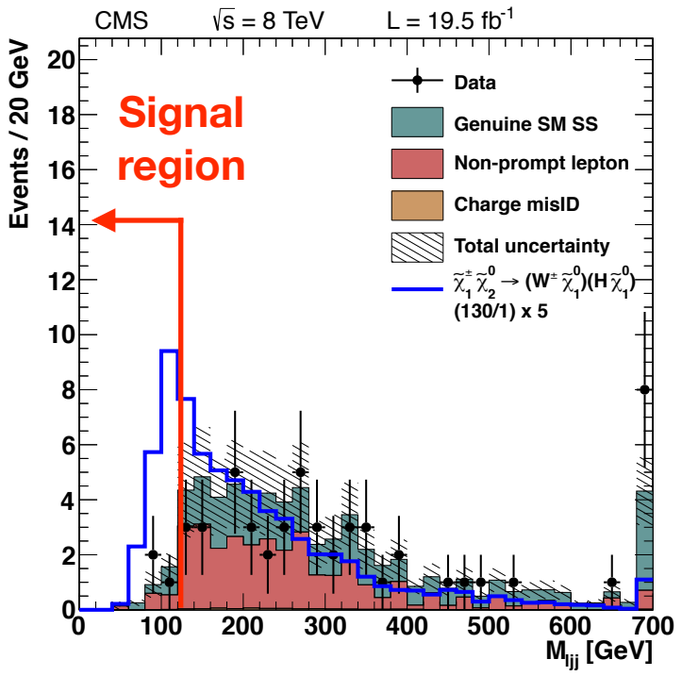
Single lepton: (h → bb̄)

Select events with one lepton and 2 b-jets.

Look for a resonance in the m_{bb} spectrum. Using E_T^{miss} bins.

Backgrounds estimated from MC with data-driven corrections.





Same-sign dilepton: (h → WW)

Select events with two same-sign leptons, no b-jets and two or three jets in the event. Extra cuts on E_T^{miss} and M_{T2}.

Non-prompt leptons backgrounds from data-driven. MC otherwise.

Look for a peak in the m_{ljj}. Not found.

Multi-lepton (re-intepretation of arXiv:1404.5801):

Select 3/4 leptons (e/μ). Including τ_{had}. Detailed binning in number of leptons, number of b-jets, E_T^{miss} and H_T.

Backgrounds estimated from MC with data-driven corrections or fully data-driven.

arXiv:hep-ex/1405.7570

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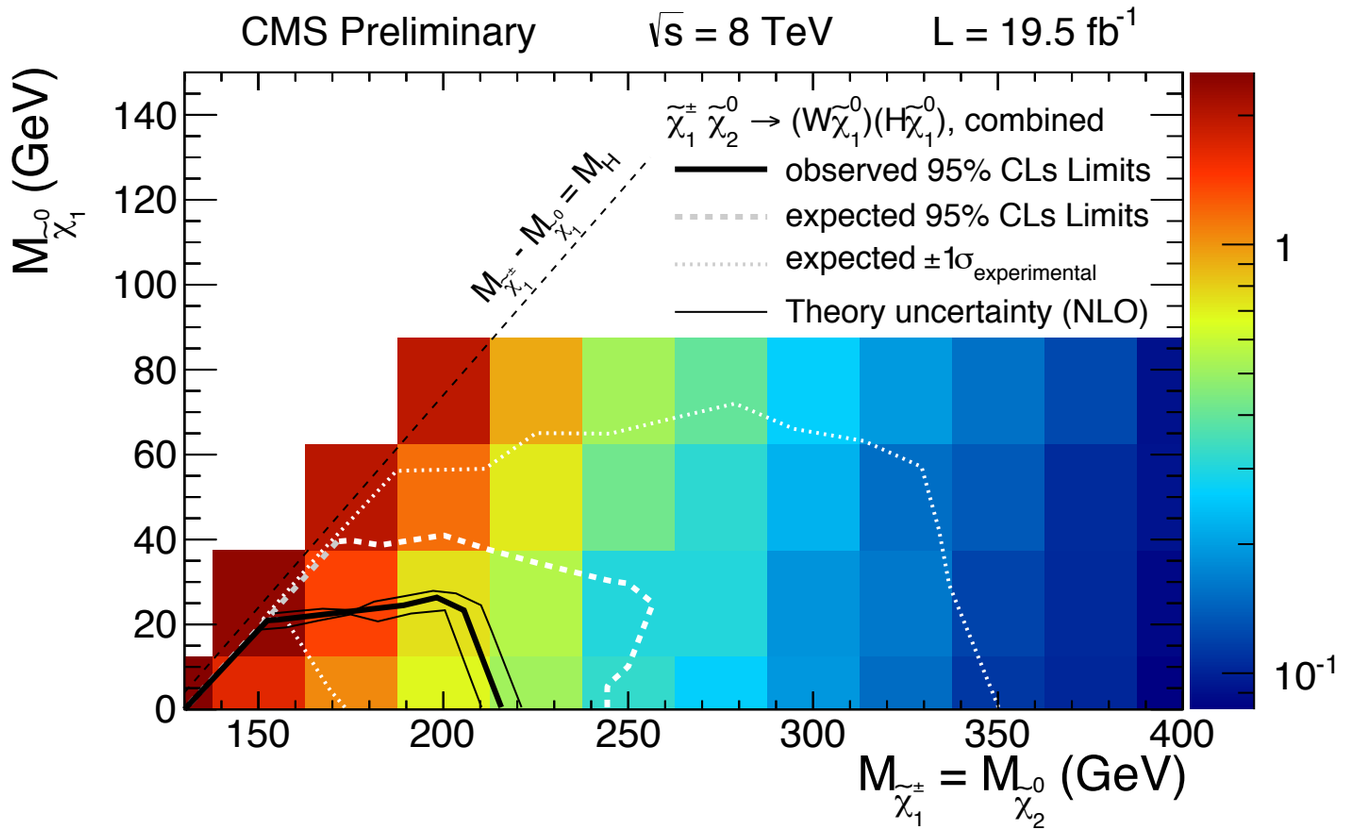
Chargino-neutralino production to hW.

New

Combination of multiple channels:

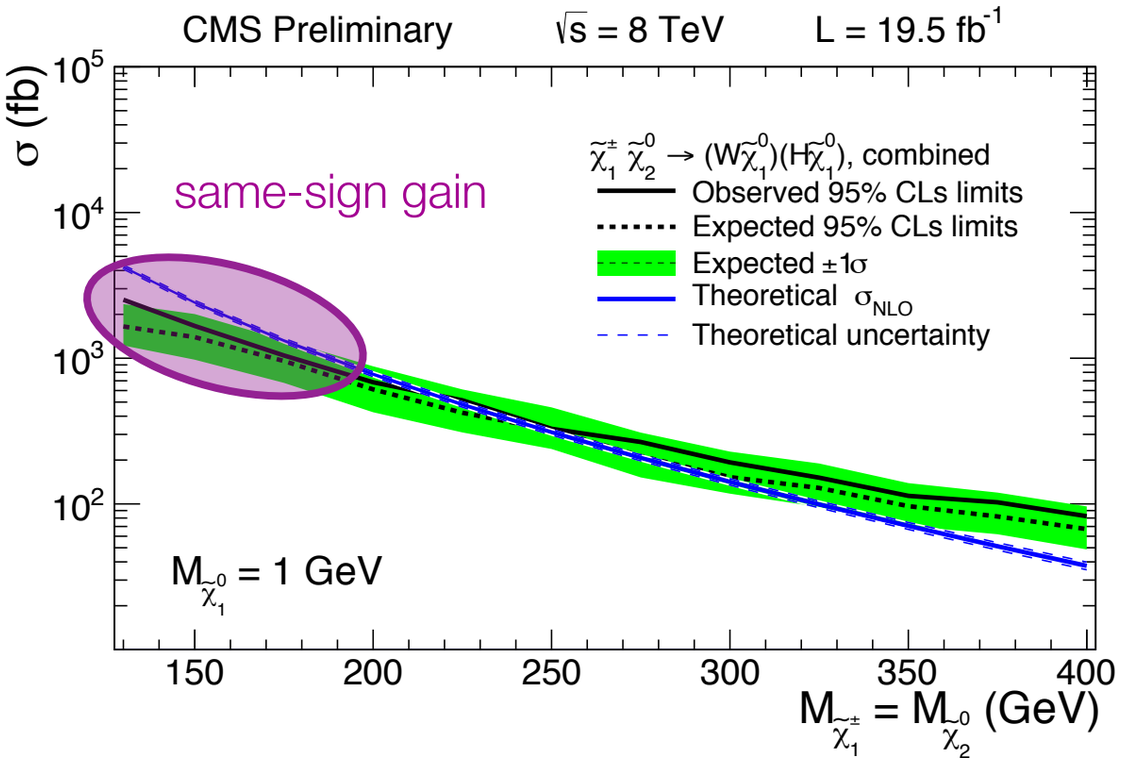


Higgs to γγ channels added w.r.t. previous published result.

Single-lepton: h(bb̄)W(lν).

Same-sign dilepton h(WW)W(lν)

Multi-lepton hh(ττ, WW, ZZ)W(lν)



arXiv:hep-ex/1405.7570 *and* ***CMS-PAS-SUS-14-002***

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Summary

Wide variety of searches for EWK production of SUSY.

Covered many final states with leptons.

Many analysis using higgs tagging now, complementing previous results.

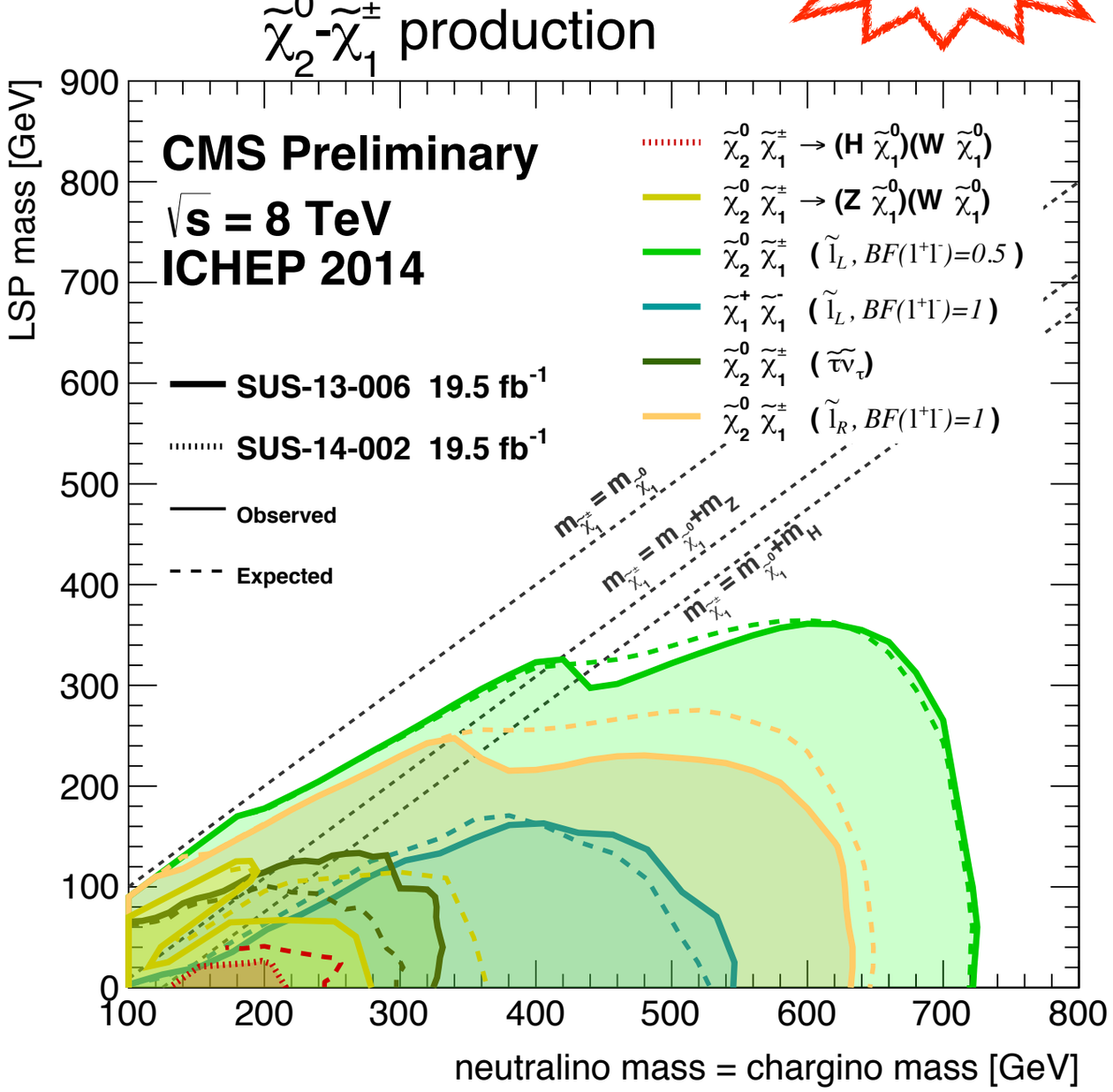
No evidence of SUSY so far.

Probing chargino-neutralino masses up to 200-700 GeV, depending on decay mode.

Higgsino masses up to 210 GeV. and (380 GeV in the GMSB model).

Stay tunned for 2015!

New



arXiv:hep-ex/1405.7570
CMS-PAS-SUS-14-002

Thank you for you attention!